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Metasequoia at the Morris Arboretum

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THE ASSOCIATES, through whose interest and generosity *The Bulletin* and certain other undertakings of the Arboretum are made possible, is an informal group of individuals interested in encouraging and furthering the educational and research endeavors of the Morris Arboretum.

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Arboretum Activities

THE STAFF

Dr. Patricia Allison, Pathologist, attended the annual meetings of the American Institute of Biological Sciences which were held at Stanford University, August 25-29. She presented a paper entitled "The Mutagenic and Injurious Effect of Filipin on *Helminthosporium sativum*," in co-authorship with Dr. J. J. Christensen of the University of Minnesota. Dr. Christensen is an Associate of the Morris Arboretum.

In addition to her duties at the Arboretum Dr. Allison is giving a course on the Morphology of the Lower Plants in the Department of Botany on the University campus.

The Director has recently given an illustrated lecture entitled "Exploring for Drug Plants in Southern Asia," to the following organizations: Garden Club of America, October 9; Bala Cynwyd Garden Club, November 7; Four Counties Garden Club, November 12; Women's Club of Downington, November 13. On October 23 he was the principal speaker at a dinner commemorating the 85th Anniversary of the Germantown

(Continued on Page 60)

The Discovery and Cultivation of Metasequoia

HUI-LIN LI

The discovery in 1941 of a living species of *Metasequoia* aroused widespread interest in botanical and horticultural circles. The revelation of the existence of a new type of conifer is in itself highly significant, but the impact of this discovery upon paleobotany, the study of the past history of plants, is even greater. Its very existence means that many long established concepts of Tertiary botany, based upon fossils alone, must now be re-examined and revised. Thanks to *Metasequoia*, we have gained new insight into the conditions which lead to the development and formation of our present day vegetation. The story of its discovery has been frequently recounted in many languages, but it is one that deserves to reach an ever-widening public.[1]

The universal interest engendered by this intriguing conifer is reflected in a voluminous and rapidly increasing literature. Since its formal designation as *M. glyptostroboides* in 1948 it has been a constant subject of scientific study and publication. In 1950 Chu and Cooper enumerated 54 articles devoted to it and in 1952 Florin cited no fewer than 130; the number must have increased several fold since that time.

Within a few years of its discovery seeds of *Metasequoia* were distributed to all important botanical gardens and arboretums throughout the world. It is now widely cultivated in Europe, Asia and North America as well as in some parts of the Southern Hemisphere. Since stock is now available from several trade sources its cultivation has also spread to many private gardens. Probably no plant has ever been accorded such rapid and wide-spread recognition and dissemination, a phenomenon made possible only in this modern age of swift world-wide transportation and communication.

ESTABLISHMENT OF THE GENUS

To begin our story we must go back at least a century. Almost a hundred years ago a fossil plant, later known as *Sequoia Langsdorfii* (Brongniart) Heer, made its appearance in the literature. This plant was shown to be wide-spread in the Eocene at high northern altitudes and at middle latitudes in North America and Asia. Subsequently many other similar fossil plants were discovered and described by paleobotanists. Most of these were named as species of *Sequoia* for they were believed to be related or ancestral to the living Redwood *Sequoia* (including *Sequoiadendron*, the Bigtree) of California. Others were referred to as *Taxodium*, in the belief that they were assignable to the same genus as the living Bald Cypress of Southeastern U. S. A. and Mexico. These fossil plants, on the strength of their presumed identity with these modern genera, are used by paleobotanists as a basis for constructing various theories about Tertiary vegetations in the Northern Hemisphere, their ecology, migration and evolution.

Many of these fossil plants, including the most widely recorded *Sequoia Langsdorfii*, however, do not exactly resemble the modern *Sequoia*, *Sequoiadendron*, or *Taxodium*, for they bear, among other things, oppositely arranged branches and leaves, while, contrastingly, all these modern genera have alternately arranged ones. This very obvious and distinct taxonomic character, interestingly enough, was completely overlooked by paleobotanists for nearly a century. Even though the material available to paleobotanists is always fragmentary, this character nevertheless is readily recognizable in nearly every specimen.

It remained for a taxonomist, the Japanese botanist Miki, a specialist on living aquatic plants, to make the long overdue diagnosis. He by chance discovered and studied some fossils and noted the striking character of opposite leaves of some that had long been credited to *Sequoia*. He also noted that the cones have decussate scales and long slender stalks. As all these characters are manifestly different from *Sequoia* or *Taxodium*, he established a new genus *Metasequoia* (1941), *meta*, from the Latin meaning "beyond," in allusion to their possible relationship.

DISCOVERY OF A LIVING SPECIES

When Miki established the genus *Metasequoia*, it was still known only as a fossil genus, one which supposedly had long been extinct. But strangely enough in the very same year, the year of a great war in eastern Asia, on the other side of the battle front, a Chinese botanist was

[1] Cover illustration by Mr. Wm. Richard Carpenter. All other photographs made by Dr. J. L. Gressitt in China in 1948 and published through the courtesy of the California Academy of Sciences.

also discovering a living tree, entirely unknown to science, but belonging to this very same genus. It is a strange coincidence, and indeed a fortunate one for science, and apparently one of the few good things coming out of the last destructive world war.

In 1937 Japan invaded China. In subsequent years the Chinese government retreated to the interior in the mountainous west and dedicated itself to prolonged resistance. Exploration parties were dispatched to little known regions in the hinterland of the country to survey and explore natural resources. At the end of 1941, T. Kan of the National Central University, while visiting the village of Mo-tao-chi, in eastern Szechuan province, first noted a peculiar deciduous conifer locally called "shui-sha" or water-fir; no specimen was then collected and it was not until the summer of 1944 that T. Wang of the Central Bureau of Forest Research collected foliage specimens and cones from the same locality. The discovery of this new conifer was first made known through publication in 1946, and was named and described as *M. glyptostroboides* by H. H. Hu and W. C. Cheng in 1948. The specific epithet referred to its resemblance to *Glyptostrobus*, a deciduous conifer of Southern China.

Introduction into Cultivation

From 1946 to 1948 Cheng sent out several expeditions to the area to collect herbarium specimens and seeds. In the meantime Dr. E. D. Merrill of the Arnold Arboretum, upon receiving herbarium specimens collected by C. J. Hsieh in 1946, realized the significance of the find and the importance of obtaining seed for propagation. With the aid of a grant made by the Arnold Arboretum, an expedition was sent out by Cheng for obtaining seed. Hsieh and C. T. Hwa were members of the party. Their exploration revealed the existence of a hundred or so large trees of *Metasequoia*, covering an area of about 800 square kilometers. The center of distribution is in the Shui-sha Valley in Hupeh province, where over 1,000 trees were found, many of them of small size and not a few planted.

A large quantity of seed was obtained and subsequently widely distributed in China, the United States and many other countries. The wide distribution of seed to botanical gardens throughout the world made by Dr. Merrill is largely responsible for its present great popularity today.

Since then the tree has been successfully raised in many parts of the world. In spite of the small area of its original habitat, it has proved hardy in widely separated regions of different continents, including such northern localities as Norway, Sweden, Finland, Southern Alaska and Central Vermont. It likewise thrives in all temperate countries.

Metasequoia is a rapid growing tree when young. Among the plants grown from seed sown

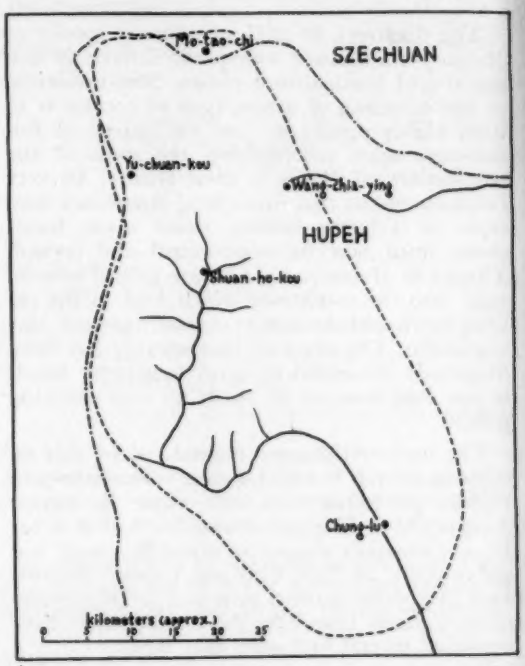

Fig. 26. *A*. A map showing the approximate limits of *Metasequoia* (indicated by dotted line).

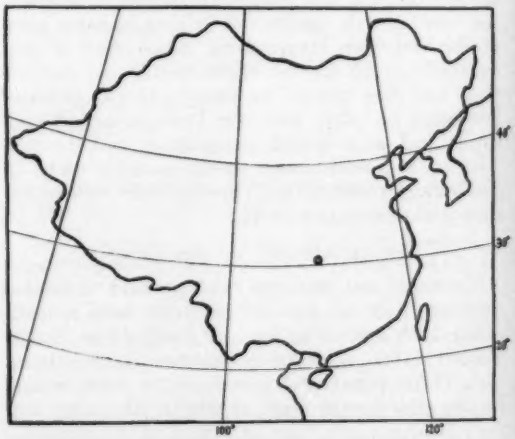

Fig. 26. *B*. Map of China showing location of A (indicated by black dot).

Fig. 27. A view of the Shui-sha Valley. Note the terraced rice paddies.

in April 1948 at the Morris Arboretum, the tallest reached a height of 5 feet 9 inches in 1949 (Skinner 1949) and now in 1957, it measures about 20 feet. (See Cover) A tree planted upon a slope has grown as fast as one planted near a pond. As much as 57 inches of growth has been observed in a single season. This rapid rate of growth is unsurpassed by any other conifers we have noted. The trees are not only rapid growing but also of well formed pyramidal shape. When the leader is damaged, it is rapidly replaced without any deformation.

In many localities trees grown since 1948 have already been reported to bear female cones. At least three such instances have come to our notice, one along the Pacific Coast, a second in New York and a third in England. In none of these cases were male flowers noted, so the cones were apparently sterile.

Although it may be many more years before most of the trees in cultivation will bear male as well as female cones and thus produce viable seeds, fortunately the tree is readily propagated by cuttings so there is no shortage of propagating stock. Green-wood cuttings taken in late summer readily took root after auxin treatment and vigorous young trees were obtained in a year or two. Cuttings taken from terminal as well as lateral branches are reported to develop equally into erect well-shaped trees.

In cultivation the trees seem to be free from any fungus disease. Few insects seem to attack them and although the ubiquitous Japanese beetle has been reported to do damage to the trees, we have not observed this adverse fact locally. Altogether the shapely form, the bright green feathery foliage which turns brownish yellow in fall, the ease and rapidity of growth, and its freedom from disease and pests, have already made this a popular ornamental tree. It may also prove to be of value as a timber or pulp tree. In any case *Metasequoia* seems to have become firmly established as one of the cultivated trees of mankind.

Original Range and Habitat

In order successfully to grow a plant in a wide variety of localities and situations one requires first of all a knowledge of its original range and habitat. In the case of *Metasequoia*, there are available several papers on the subject based on first hand observations.

Early in 1948, Chaney made a hurried trip to the homeland of *Metasequoia* spending a few days in the field. Since it was winter, little could be observed or collected (Chaney 1948). In the summer of the same year, Cheng, together with Hwa and Chu, explored the area for several months and later Chu reported his observations in a joint paper with Cooper entitled "An ecological reconnaissance in the native home of *Metasequoia glyptostroboides*" (1950). This is the most detailed study of its kind. During the same summer, Gressitt also conducted an expedition to the region and spent considerable time in the field collecting primarily insect specimens. His travels and observations are reported in a paper published in 1953.

The first map showing the range of *Metasequoia* is given by Hu and Cheng (1948) in

Fig. 28. Another view of the Shui-sha Valley.

Fig. 29. A waterfall and a covered bridge in the Shui-sha Valley.

the paper which contains the original description of *M. glyptostroboides*. Chu and Cooper (1950) later gave a more detailed map showing its range. While Gressitt's paper does not contain a map, his account of his journey shows that the area covered by him is more extensive than Chu's. He actually discovered and observed many scattered specimens outside the range given by Chu. By carefully checking over Gressitt's itinerary and observations, it is found that the range needs extension southward beyond Lat. 31°, south of the city of Chung-lu. A revised map based on the original ones given by Hu and Cheng and Chu and Cooper and incorporating Gressitt's additional observations is given here (Fig. 26). The area of the original range of *Metasequoia* in this map is about one-third larger than that given by Chu and Cooper, estimated by them as covering 800 kilometers.

Metasequoia is found in West Central China, in the northwestern corner of Hupeh province, ranging at points slightly across the border of Szechuan province. It occurs primarily in the Shui-sha Valley, a narrow close depression at a relatively high elevation (700-1350 m.) in a sandstone region. The natural habitat of the tree is in shady and moist localities on slightly acid or circumneutral sandy soils. In this region the species occurs as a constituent of a presumably natural and actively reproducing forest community. (Figs. 27-30).

Fig. 30. Forested mountain slopes of the Shui-sha Valley. The tree in the foreground is a *Cryptomeria*.

The tree grows mainly in ravines from high up the mountain slopes down to the floor of the valley. It thrives best along the rocky banks of small streams and seepage grounds at the foot of the slopes forming dense thickets with other trees and shrubs. It is essentially a member of a stream-bank community. (Figs. 31 & 32). Moist soil and humid atmosphere seem to be essential for its successful reproduction. Seedlings are found in such moist localities. Gressitt reports that though the trees are generally erect, sometimes young individuals have widely spreading branches making them as broad as high, like yew trees in the valley.

The trees frequently associated with *Metasequoia* include three conifers, *Cunninghamia, Cephalotaxus Fortunei* and *Taxus*, and some thirty angiosperms including *Liquidambar formosana, Castanea Sequinii, Rhus spp., Cornus controversa*, and *Lindera glauca*. The commonest shrubs are species of *Spiraea, Hydrangea, Viburnum, Morus, Berberis* and many others. Woody climbers include *Hedera, Rosa, Parthenocissus, Akebia, Actinidia, Lonicera*, etc.

Fig. 31. A grove of *Metasequoia* trees.

It can thus be seen that the natural vegetation is primarily moist mesophytic and warm temperate in nature. No climatic data are available from the region, but observations of and comparisons with nearby areas show that it is a region of mild winters and hot summers, with the highest precipitation in spring and summer months. Frosts are probably infrequent and light. Chu and Cooper believe that a near climatic parallel in North America is the southeastern coastal plain, e.g., Georgia.

Fig. 32. A grove of *Metasequoia* trees.

Cultivation in its Original Range

In its original center of distribution, the Shuisha Valley, there has been considerable planting of *Metasequoia*. Seedlings and young trees are constantly being removed from native sites to be planted along the banks of the main stream in straight rows and along the margins of the rice paddies, along road-sides, and in home-yards. The tree, however, is of little economic importance there. It is planted for aesthetic purposes and is used only incidentally for fuel and in construction. The wood is not considered to be of good quality.

There is a prevalent local custom of periodically cutting the branches of *Metasequoia* as well as *Cunninghamia*, often almost to the top. Most of the trees outside the shady ravines have thus an extremely slender appearance, a straight trunk with new branches growing out laterally. (Fig. 33).

Prospect in Cultivation

The rapid increase of popularity in the cultivation of *Metasequoia*, aside from deliberate dissemination and effective advertising, is due to its novelty and its intrinsic ornamental value. Because of the former it will always hold an indispensable position in any botanical garden, and because of the latter, it is now fast becoming a most desirable tree for public parks and private gardens all over the world. The ease of cultivation, rapid growth, and freedom from pests and diseases undobtedly greatly enhance its value as an ornamental tree.

Fig. 33. A *Metasequoia* tree planted near farm house by the side of rice fields. Note how the tree is closely cropped.

In addition to becoming a popular specimen tree in botanical gardens and on private lawns, *Metasequoia* seems to have further values as a useful cultivated tree. Being a deciduous conifer and generally of a narrow pyramidal shape, it can be used for lining avenues and walks. The lower branches can be trimmed off when planted along city streets or where space is at a premium. It may prove to be of comparable value to *Ginkgo*, now so extensively used for this purpose. The deciduous habit will enable it to withstand city atmospheric conditions which are usually injurious to evergreen conifers.

As the wood of *Metasequoia* is not considered of good quality, the tree is apparently not promising as a timber species but its rapid growth seems to indicate that it is potentially a desirable pulp tree for certain regions. Its actual rate of growth for a given area can of course only be determined by experimental studies, but its rapid growth as reported in many regions seems to indicate that it can be widely explored for this purpose. Another desirable attribute of *Metasequoia* is its monotypic nature, that is, it is the only species of a genus and has no close relatives. Since it is essentially free from insect pests or fungus diseases its introduction into a new region is therefore not likely to result in the introduction of new diseases which would constitute a threat to the native trees.

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Trouble-Shooting Strategy

PATRICIA ALLISON

"What shall I do?" "Where shall I do it?" "When shall I do it?" If your search for disease and pest control information includes all three of these inquiries, you already have a fair concept of the basis of good control practices, for you are aware of the necessity of correct placement and timing as well as the correct method.

Successful control of diseases and pests results from the strategic intervention of man at crucial points in the cycles leading to destruction of the plants. What is crucial in one cycle may not necessarily be crucial in another, however. Clearly, one of the first objectives should be preventing the host and parasite pest from getting together in the first place. This is not always possible. Failing this, we usually attempt to prevent the build-up of large populations of damaging organisms and to minimize the damage once the host plant and its enemy have come together. How can we do these things? There are naturally three main avenues of attack: We can manipulate the host plants; we can manipulate the environment; and we can declare war against the pathogens and pests themselves. Your job as the gardener is made easier by the achievement of some of these goals by others before you ever purchase the plants and set them out. No matter what is done, or by whom, doing it at the right place at the right time is imperative.

KEEPING PLANTS AND THEIR PESTS APART

The immigration of some plant pathogens and pests into an area in which the host is being cultivated can be prevented. The area can be large or small – large as a continent, small as a flower pot. Commonly this type of control can be exercised only with those pathogens and pests that would be initially distributed through man's activities anyway. True, they may be perfectly able to disseminate by other means once they have arrived, but the first step is the crucial one. And since man's activities can be regulated to some extent, legislation and its enforcement are among the techniques employed in preventing plants and their pests from getting together. It is difficult to do.

On a national basis, attempts are made to exclude from our country pests that are known to cause serious losses at their points of origin. Furthermore, attempts are made to exclude pests which might not be particularly damaging in their home grounds but which could very well create havoc in a new territory where hosts may be more susceptible, natural enemies absent, and environment more favorable. This means that some plant species cannot be shipped from certain parts of the world under any circumstances whatever for commercial use in the United States. Thus legislation and its enforcement protect your rose garden from one of its most destructive enemies, rose wilt, caused by a virus present only in Italy, Australia, and New Zealand. The same embargo, of course, protects American nurserymen from loss of their rose crops.

It is not possible to discern all potential enemies by inspection, even microscopic inspection, at ports of entry. Consequently many types of plants, apparently healthy ones included, must be planted out and observed carefully for two years by government inspectors before release for commercial use. Sometimes symptoms of disease cannot be observed in dormant stock arriving in this country and close observation during active growth is the only fair means of protecting both receivers and shippers.

Permission for distribution may be refused because plants carry with them stowaways that are not their own pathogens but are the pathogens of other crops. This often happens with propagative stock such as pips of lily-of-the-valley that were lifted from fields infested with the golden nematode of potato. Particles of soil clinging to the rootstocks harbor cysts of this pathogen that has caused enormous crop losses in Europe. So, regulation must extend to all types of plant introductions, and even to wrappings, boxes, and particles of soil on apparently bare roots.

In addition to embargoes and quarantines on a national scale, there are regulations restricting the movement of plants, soil, and farm machinery from state to state, or county to county. Unfortunately, the golden nematode did become established in one of our potato growing areas, Long Island, but interstate restrictions prohibit the further wanderings of this pathogen. Within states there are various statutes designed to protect nurserymen and consumers alike.

Keeping plants and their enemies apart is not the exclusive province of government agencies by any means. Individual nurserymen often establish their own "legislation" simply because it's good business. Thus the principal supplier of rooted chrysanthemum cuttings in the United States makes sure that all his stock harbors none of the main troubles of this plant. This method of control, keeping host and pathogen apart, can be used by growers themselves in the control of a number of pathogens, such as those that lurk in the soil. Any gardener who has had phlox die of Verticillium wilt or roses die of bacterial crown gall certainly shouldn't mix soil from those areas with soil in beds supporting healthy plants. Furthermore, when you insist on disease-free stock from your nurseryman, you prevent the introduction into your garden of many troubles that are among the most difficult to control thereafter.

There are other ways of keeping host and pest apart. An important one is controlling insect vectors – those insects that carry fungi, bacteria, or viruses with them to the host plants. This is extremely important, for example, in helping protect valuable plantings of elm from the Dutch elm fungus, and in protecting asters and other hosts from the virus causing aster yellows.

Keeping plants and pests apart is certainly not possible with all types of diseases and pests, and manipulating the environment is often impossible in utilizing this method of control. Who could command the winds to blow the billions of microscopic reproductive bodies of some fungi away from susceptible foliage? Who can command a mountain range or an ocean to appear between his crop and flying or wind-blown insects? No, only a fraction of the troubles of plants can be lessened by attempts to keep host and pest separated by space, and even these depend on correct location and timing of the attempts.

Preventing the Build-up of Large Pest Populations

Enactment of laws or borderline interception do little to help if a pest has already been introduced and is well on the way toward becoming established and disseminated.

There is one measure that has proved worthwhile in some cases of record, however. That is the prompt eradication of all diseased host plants in the limited geographic areas of introduction before the natural methods of dissemination of pests have made such a program hopeless. Success of such attempts to reestablish a separation between host and pathogens is wholly dependent on early recognition of invasion and knowledge of the biology of the invaders. How hopeless were the attempts to eradicate Dutch elm disease and chestnut blight. How great are our losses as these magnificent trees disappear. How splendid was the victory, however, over citrus canker in Florida and Texas. Introduced in about 1911, recognized in 1913, eradication of this ruinous disease was begun as early as 1915 – a mobilization of forces whose timeliness is matched only by the arrival of ants at a picnic. Hundreds of workers toiled; hundreds of thousands of trees were removed from groves; millions of dollars were spent, but an industry remains intact, yielding more in a year than the total expense.

Total eradication is rarely possible, but there are many, many other ways that pest populations are limited, and here's where the work comes in. This is the battle we carry on day by day, season by season. Our strategies and weapons are as varied as the host plants we protect and as devious as their enemies we despise. Sometimes we lose, sometimes we win, but always a horde of hidden troops is battling at our sides. These allies are the "natural" antagonists of the pests we hope to conquer. Without them we probably would not have a ghost of a chance of maintaining ourselves and food crops, let alone the ornamental plantings that enrich our outlooks.

Recall that a single aphid egg in spring is the first of a season of a dozen or more generations, representing the potential of over a billion hungry little animals. Recall that a single successful microscopic fungus spore can give rise to a lesion on a plant in which a quarter of a million new spores are formed. Were each of these in turn successful, in ten days' time there could be some 62 billion more ready for action! This does not happen. Chief among the natural restrictions to pest populations is the non-living environment itself. Winds, rains, and animal vectors do not collect all spores and transport them directly to succulent host plants. Untold numbers are wafted to the upper air and die. Myriads of others are dashed to earth where they germinate to no avail. Countless others lodge on plants foreign to them. Many reach their host plant destinations alive, but because of improper temperature or improper humidity, or lack of liquid water, perish there just outside the storehouse door. And there are the luckless millions that never survive the rigors of winter or the parching heat of summer.

Those pests that can withstand the buffeting of their non-living environments are fair game to the rest of the living world. Insects gorge themselves on spores; diseases beset insects; fungi lasso nematodes; bacteria and viruses probably

afflict them all. Plant parasites and pests are even victims to their near relatives. Some fungi parasitize other fungi or poison their substrates; some insects destroy the young of other insects or lay their eggs in the bodies of other insects. Even stricken host plants themselves limit the reproductive potential of their own parasites. How many fungous or bacterial lesions can a leaf withstand without falling? Sometimes only one will cause it to die or break off. By perishing thus, so also do some of its pathogens. By early death of some plants, others may be protected from the massive onslaught of an overwhelming population of virulent pathogens.

It is the mighty minority, living on, surviving the dormant season, arriving at the host plant at the proper weather-time, at the proper susceptibility-place that we must do battle with. At times the tremendous curtailment by the environment of survival, reproductive capacity, and dissemination falls short and populations develop that are incomprehensible in numbers and destructive powers. These are set down as bitter embellishments of our history. Such was the dreadful potato famine in Ireland that resulted in death or immigration of 2½ million people. Such, too, was the near destruction of the French wine industry when production was reduced more than three-fourths by a fungus immigrant from the New World. Such, too, have been the ravages of the locusts, blackening many a summer sky as they have swept from field to field throughout our history.

These are national disasters. It happens also on smaller scales — in a county, on a farm, in a garden. It can happen when environment favors survival and development and when we, through our inactivity or carelessness, permit pests to take their tolls.

Most of the individual grower's control methods are population limiting methods, and most of these are protective measures rather than remedial measures. We try to keep plants healthy rather than cure them once the disease strikes. Again, we can use several approaches: directing an attack at the causal agents, altering the environment, and altering the host. Many techniques involve all three.

Successful attacks on causal agents are based on their habits and locations. Where does the pathogen overwinter? When does it resume activity? What part of the plant does it affect? How does it do its damage? All of these are important questions. Don't grab up a spray gun in blind panic and hope for the best. There are many things you can do to limit populations in addition to visiting that mysterious pesticide shelf at the garden store. Among the most important are sanitary practices in the garden and thoughtful planting schemes. Some of the principles learned in agriculture are also important at home. Limit populations by destroying their overwintering stages. Prune off egg masses of the tent caterpillar, for example. Many fungi, bacteria, and insects spend this season in or on dead plant parts. Collect and burn old rose leaves and spotted canes. The black spot fungus overwinters there and sends up showers of spores in spring. A giant step in disease control has been taken if this primary spore shower can be reduced. Remove dead tops of iris and tulips in fall and burn them. Sort out unhealthy bulbs and corms you may lift for the winter. Don't compost dead plant materials unless you *know* they are disease-and insect-free. It's a good idea to practice crop rotation too, changing the location of species in bulb and border plantings every few years. Be sure that you replant only healthy plant material, however.

Populations can also be reduced during the growing season and over winter by eliminating weed hosts. Many insects begin their season's activities in weed patches, and about the time their appetites are really whetted, move on to your favorite garden plants. Similarly, they may prolong their feasts in the fall on weeds. They may even carry viruses from weed hosts to garden hosts.

Eliminate alternate hosts when possible. If you like ornamental crab trees, don't develop a Juniperus passion unless you are prepared to baby both of them. The cedar-apple rust flourishes when both types of host are in the same vicinity. If the hosts are widely separated, the rust fungus can bother neither one of them, since it must pass a part of its life cycle on each, and one of the several types of spores formed just can't stand a long journey.

Exert some control on the environment, even the outdoor environment. Space plantings of zinnias, for instance, so that the lower leaves will not be shaded and crowded. This will help prevent such a rapid build-up of the powdery mildew fungus. In general, it's much better to water all your outdoor plants at ground level rather than by drenching the foliage in the process. Be sure that the soil is adequately drained in shady low spots so that the plants growing there won't be in a fog half the time.

Now about the matter of chemical sprays. Although acting at the surface of plants, they really are there to kill off as much of the attacking pest population as possible. Rarely is there one hundred per-cent success, but correct timing and complete coverage increase the percentage of kill of the attack force. Often during the skirmish

season, it is necessary to renew the application as new waves of pests approach. Altogether, the development of such chemicals to apply in the first place is a marvelous achievement. Just imagine what is attempted: Here we have living organisms, our valued plants. On the other side are other living organisms, the pests. In the middle we stand, also living organisms. Now, the basic, essential inner workings of us all are similar. We all utilize foods – fats, carbohydrates, proteins (the green plants making their own); we all utilize minerals; we all utilize oxygen; we all burn the food in one way or another and gain energy from it. Yet when we apply pest control chemicals to our plants we are reasonably confident that they *won't* kill the plants, that they *will* kill the *pests,* and that they *won't* kill us if we use them properly. This is called selective toxicity, and that last *if* is extremely important to us. This selective action is at its best at certain definite concentrations discovered during the research which resulted in the development of the chemicals. We must therefore be sure to follow directions absolutely, because too much may harm the plants, some more than others perhaps, and too much may also harm us. Always store the chemicals in a locked cabinet; always bear in mind your kinship to the whole living world when you use them.

Pest control chemicals are mainly protective. This means that they must be in place, all ready to affect the plant pests when they arrive. Here it is important to know something about the pest that causes the trouble. If it is an insect, it won't be very helpful to the plant to apply a fungicide. It will be helpful to you to get out into the fresh air and enjoy the exercise involved in the application, but in the meantime your adversary lives on, thumbing his nose, so to speak. So look for clues; the insects or pathogens themselves, webs or frass, the appearance of their damage. Your garden book on diseases and pests will be most helpful. Thanks to the broad-spectrum insecticides with high residual activity now on the market, it is not so important as it once was to know whether or not insect pests were chewing or sucking types, the one controlled by stomach poisons, the other by contact poisons. Thanks also to the interest of suppliers of pesticides in the home market, there are many preparations with combined ingredients to provide the maximum protection from the largest number of pests. It is important for example, not to allow one type of pest to multiply on a grandiose scale because you have unwittingly killed off its natural predators along with some types of plant pests. Thus mites can become cock-of-the-walk if DDT alone has been used in insect control. DDT has an exceedingly broad spectrum of activity, killing many types of insects, including the predators of the mighty mites.

Where is the correct place to apply these materials? Yes, here it is important to know something about the location of the pest. If the pale foliage or dieback of shrubs is due to the activities of fungi or insects working on the roots, it is foolish to cover the leaves with chemicals which can do no good. Similarly, since many disease fungi and insects do their work on the lower surfaces of leaves, the chemicals should be there when they begin.

When should they be applied? This will depend largely on the type of pest. You can rest assured, however, that when your ornamental plantings resume growth in spring their pests aren't going to remain dormant very long. The first important time to watch for damage, then, is early in the growing season. At the first signs of trouble, protect your plants. There are a good many ornamentals, such as roses and dogwoods, that should be protected from the word go without waiting for a sign of trouble, roses against black spot, of course, and dogwoods against borers. During the growing season keep close watch for any secondary build-ups of pests. In fall, when cleanup is so important, take stock of your pest control prowess. If you failed in some instances, your best defense the next spring may well be to attack the pest before it resumes activity. These dormant or delayed dormant sprays are important in control of many kinds of insects, among them hard-shelled scales and mites. General protective sprays later in the season have then only to reduce the small surviving population. Dormant sprays are also important when black spot has been severe in rose gardens to kill developing spores in spots on canes that cannot be pruned out.

At times the application period for chemicals may be dictated by the chemicals themselves. The soil fumigants as a group are damaging to plants. This means, then, that the soil to be treated for nematode control usually must be fallow, then treated, then aerated, then planted. Soil fungicides, although not as toxic as nematocides, are also most conveniently applied before or at planting time. Seed treatments are frequently directed at the pests in the soil that would harm the tender seedling as it emerges. The surrounding soil is thus treated when the seed is planted.

The big things about chemical control are these: recognize the existence of a problem; narrow down the cause; purchase the correct material; apply it correctly; apply it at the correct time; apply it as often as neccessary. An operator of one of the finest garden stores in this area reported recently that a customer did all of these

up to and including purchase of the correct material. Some time later however, the same customer complained because the material did nothing whatever to control his trouble – even though the package had been right out there in the garage all the time! The ancient Romans used to pay tribute to their rust god, Robigus, in order to limit plant disease. The garage shelf method is just about as effective.

Minimizing Damage after Host and Enemy Are Together

With some crops it just isn't economically feasible to attempt eradication or chemical control. This can be because the crop and its pests are so widespread, or it can be because of the value of the crop and its method of cultivation. Controlling wheat rust by use of present day protective chemicals is theoretically possible, but never practiced. Thorough coverage and several applications would be necessary. Neither is possible on a practical basis. Forest trees present a somewhat similar problem. Application from the ground is virtually impossible. Applications from the air, at great expense, are successful in limiting some severe insect outbreaks but cannot be used routinely. What other courses are open? Damage can be minimized through long-term planning. Here the chief attack is through the host. Plants can be developed that just do not suffer as much as others from the attacks of their many enemies. Geneticists and plant breeders throughout the world work to include resistance to disease and insects among the valuable characteristics of their new varieties. This includes the development of resistant varieties of ornamentals and forest trees as well. There is great variation in susceptibility to diseases among varieties of such ornamentals as asters, carnations, chrysanthemums, gladiolus, tulips, and roses. Relative resistance to common diseases of roses, as a matter of fact, is one of the qualities considered in establishing the national numerical ratings of rose varieties.

Damage is also minimized by altering the host plant when we prune off diseased portions to prevent continued development of a pathogen.

The use of various chemicals is also becoming more important in limiting damage by pests once the pest and host plant come together. Here it is difficult to say whether we are manipulating the host or the pathogen, but the result is good and we will probably see many more materials in this field of "chemotherapy." Actually the object is to get something inside the host plant that will thwart pathogens when they attack. Thus there are compounds such as sodium selenate that can be applied to the soil around certain plants and successfully control some nematodes and even insects attacking the foliage. The insect, as it plunges its proboscis in for a meal, is poisoned by the chemical before damage becomes severe. These materials, then, act as internal protectants. Considerable research is in progress in this field to develop both fungicides and insecticides. Already there are some experimental ones, that when used as seed treatments for a certain crop, render the young seedlings resistant to a number of their common insect enemies for a period of several weeks.

Another group of chemicals acts slightly differently. They are not internal protectants, nor do they act in an exclusively protective fashion on the surface of plants. Rather they can penetrate leaf tissue and destroy young fungus growths already established there. Some mercurials and sulfurs are reported to act this way. Another chemical has the same type of role, but you do not know it as such. It's water – good, fresh water. This "fungicide" is frequently heated to a particular, highly critical temperature, then used as a dip for a particular, highly critical length of time with such plant parts as seeds, bulbs, corms, and root stocks. The object is to inactivate the internal pest, such as fungus or virus, without parboiling the host plant.

Manipulating the environment is also effective sometimes in reducing the damage of plant pests already in or near the host. Thus, abundant watering will sometimes minimize the symptoms caused by root-attacking insects, nematodes, or fungi. Similarly, proper fertilizing will aid in keeping whatever natural resistance a plant may have at a peak. Too much of one mineral element on the other hand, may increase susceptibility. This happens when a relative abundance of nitrogen causes much soft, leggy growth. Such tissue is more susceptible to various bacterial diseases. Of course, manipulating the environment is the most important method of attacking the other large category of plant troubles – the non-parasitic ones. These include mineral deficiencies, drought damage, acidity difficulties, and, oh yes, banging into your favorite tree with the lawn mower.

In another article we will talk about label reading and the characteristics of some of the commonest pesticides.

Woody Plants Suitable for Circumneutral Soils

EDGAR T. WHERRY

There was published in this Bulletin several months ago[1] a list of woody plants which experience has shown thrive best in decidedly acid soils. Requests have subsequently been received for information as to species adapted to soils which prove on testing not to be acid, or in which the acidity has been neutralized by adding lime. The term circumneutral soil is applied here because under the climatic conditions of the eastern half of the United States, where most readers of this Bulletin have their gardens, soils never become markedly alkaline, but when acidity is reduced remain fairly close to neutrality.

Just as there is one major group of woody plants – the Heath Family – characteristic of acid soils, there is one including many ornamentals – the Rose Family – most members of which thrive best under circumneutral conditions. To it belong the horticulturally important genera *Cotoneaster, Crataegus, Malus, Prunus, Pyrus, Rosa, Rubus, Spiraea* and so on. Many members of the related Legume Family also favor circumneutral soils, although Black Locust *(Robinia Pseudo-Acacia)* is tolerant of considerable acidity.

[1] Vol. 8 pp. 19-20, 1957.

Woody-plant genera in other families comprising many circumneutral soil species are:

Abelia	*Euonymus*	*Philadelphus*
Aesculus	*Forsythia*	*Platanus*
Berberis	*Hedera*	*Rhamnus*
Buddleia	*Hydrangea*	*Rhus*
Buxus	*Juglans*	*Syringa*
Carya	*Juniperus*	*Thuja*
Clematis	*Ligustrum*	*Tilia*
Deutzia	*Lonicera*	*Ulmus*
Elaeagnus	*Morus*	*Viburnum*

While testing with indicators to ascertain if a given soil is acid or circumneutral is always desirable, there is one plant which will itself serve as an indicator – the Blue Hydrangea, (*Hydrangea macrophylla*). When grown in an acid soil, the flowers of this species show their blue color strikingly; but in a circumneutral soil they tend to become pink instead. One can indeed obtain both hues on the same bush: spread a few ounces of crushed limestone on the ground at one side, and of aluminum sulfate at the other. In the course of the season the effect of these substances in changing soil reaction will be made evident by contrasted flower coloration.

The Handbook of Hollies

We are pleased to call the attention of our readers to the publication of the "Handbook of Hollies" which has recently appeared as Volume 36 of the National Horticultural Magazine. This superb contribution to the growing literature on an important group of ornamentals represents the combined efforts of members of the Holly Society of America, ably edited by Harry W. Dengler.

An introductory section contains an article on Holly Folklore and Legends, a general statement on the Hollies of the World, and detailed treatments of North American, Oriental and English Hollies. These regional accounts are provided with analytical keys as well as brief descriptions of individual species, varieties and cultivars.

Of considerable value to holly-growers is the section dealing with the Culture of Hollies. This includes articles by competent specialists on Planting, Pruning, Pests, Diseases, Propagating and Hybridizing.

A third, and final section, devoted to the Uses of Hollies, contains, among other things, chapters devoted to the use of hollies in landscape architecture, as hedges or screens, as topiary and bonsai subjects, and as cut material.

The Handbook, which consists of some 200 pages, is copiously and sumptuously illustrated with half-tones and line drawings. It may be obtained, at a cost of $3.00, from the American Horticultural Society, 1600 Bladensburg Road, Northeast, Washington 2, D. C.

J. M. F., Jr.

Arboretum Activities

(Continued from Page 48)

Horticultural Society. His topic was, "Some Early Philadelphia Botanists." On November 18 he spoke to the West Chester Garden Club on the subject, "The Plant Ecology of Southeastern Pennsylvania" and on November 21 he gave an illustrated lecture to the Philadelphia Botanical Club entitled, "A Botanist in Southern Mexico."

On November 8 the Director and Miss Mary Milton, Propagator, represented the Arboretum at the annual meetings of the American Holly Society which were held at the Longwood Gardens. Miss Milton also attended the annual meetings of the Plant Propagator's Society in Cleveland, Ohio, November 21-23.

Dr. H. L. Li, Taxonomist, returned on November 23 from a three months' stay in England where, thanks to a National Science Foundation grant, he went to continue his studies on the trees and shrubs of Formosa. It is hoped that in a future issue of the Bulletin Dr. Li will favor us with an account of his experiences abroad.

The Fernery

The task of replacing the glass roof of our tropical fern house has been completed and this attractive feature of the Arboretum's exhibits is once again open for inspection. The new roof is a monument to the ingenuity and painstaking workmanship of our builder, Mr. Thomas J. Carney, who designed and constructed it.

Walks and Roadways

In line with our established policy of hard-surfacing additional sections of our walks and service roads each year, we have this autumn completed the task of surfacing the winding walk which leads from the Morris Mansion down to the Rose Garden. We have also surfaced several hundred feet of the roadway which leads through the Hawthorn and Lilac collections, turns south past the native Azalea planting and ascends the slope along the Germantown Avenue side of the Arboretum.

Housecleaning

One of the ever-present problems in the maintenance of an Arboretum arises from the most natural of causes: namely, growth. As trees and shrubs continue to increase in size we are presented with the necessity of pruning, cutting back or, in some instances, actually cutting down, long-established specimens.

When two neighboring plants develop to the point where they threaten to crowd each other out of the picture, then a decision must be made as to which is the more valuable and should be retained, while the other, if it is too large to move, must be sacrificed.

For example, one of the rarest and most interesting plants in the Arboretum is the Chinese Dove tree, *Davidia involucrata,* which is to be found on the edge of the Swan Pond. During recent years this handsome specimen has become increasingly crowded by other trees growing next to it. It has been necessary to deal rather drastically with this situation in order to preserve a valuable plant and to show it off to the best advantage.

Another instance of the bad crowding of plant material was to be seen on the south slope below the Rose Garden. Here, in one of the oldest established plantings in the Arboretum, many man-hours have been spent this autumn in cutting out and pruning back a veritable jungle of vegetation. The result is the reopening of vistas long obscured and the showing to real advantage of many handsome specimens which had been all but hidden from sight.

Plant Distribution

The annual distribution of plants to our Associates took place on Friday and Saturday, October 25 and 26. About 40 different species and varieties were arrayed on the porch of the Morris Mansion and more than 200 Associates took advantage of the opportunity to come and receive at least two plants of their own choosing.

In the September issue of the Bulletin Miss Milton invited an expression of opinion from our readers as to the time of year which they considered most favorable for our plant distribution. The response indicates that Spring appeals to many Associates in preference to Autumn. We shall therefore plan to hold our next Distribution Days in the Spring of 1959.

J. M. F., Jr.

New Associates

The Arboretum is happy to welcome the following new Associates who have been enrolled since March, 1957:

Mrs Jack Ackoff
Mr A. H. Alexander
Dr and Mrs Mark W. Allam
Mr and Mrs Donald K. Angell
Mr William Bandes
Mr Fred W. Bergman
Mr Benjamin Blackburn
Dr T. E. M. Boll
Mrs Willard Boothby, Jr.
Mr H. J. Brunkhorst
Mrs J. Ebert Butterworth
Dr J. J. Christensen
Mrs G. Dawson Coleman
Mrs Harry L. Curtis
Mrs Walter Darlington
Mr H. Hoffman Dolan
Mrs Paul Domville
Mr and Mrs Joseph N. DuBarry, IV
Mrs Addison S. Ellis
Dr Katherine O. Elsom
Mr Benjamin Eshleman
Mrs Brooks Evert
Mrs J. Howard French
Mrs Clinton W. Frontz
Lt. Colonel & Mrs Kenneth Gardner
Miss Marian K. Grace
Dr F. C. Grant
Mrs Harry W. Harrison
Mr and Mrs Edward N. Hay
Mrs Morgan Hebard
"Henry" c/o Col. Howard C. Fair
Mrs Charles E. Hodges Jr
Mrs J. P. Hollingsworth
Mrs James Hornor
Mr and Mrs Jacob Hossler
Mrs Willing Howard
Mrs Cortlandt Van Hubbard
Mrs Walter Jeffords
Mrs Lawrence Jewett
Mrs William A. Kelius
Mrs G. Walker Ketcham
Dr and Mrs Edward Krumbhaar
Mr David Lane
Mrs Edward Law
Mr and Mrs George A. Lear
Mrs Edward McCloskey
Mr Henry H. Meigs
Mr E. Matthew Miller
Mrs John W. Moffly, III
Mr and Mrs Royal F. Morris Jr
Mr George S. Munson
Mr and Mrs Charles Myers
Mrs A. E. Newbold
Mr and Mrs Otto J. Patzau
Mrs George W. Pepper, Jr
Mrs George W. Pepper, III
Mr George B. Peters
Mr B. L. Palmer, Rose Valley Nurseries
Mrs Henry Norris Platt
Mrs J. Nevin Pomeroy
Mr G. Gardner Richards
Mrs C. L. Ritchie
Mrs Richard M. Saul
Mr and Mrs Francis H. Scheetz
Mr Harold W. Scott
Mr C. Scott Seltzer
Mrs Howell Lewis Shay
Mrs Edward G. Shmidheiser
Mr A. McKnight Sykes
Mr Otto Stern, Stern's Nurseries
Mr John J. Stevens
Mrs O. J. Toland
Miss Elizabeth Trotter
Mrs Miles Valentine
Dr Paul A. Vatter
Mr W. Romine Wallace
Mr William H. S. Wells
Mr Warren F. Williams
Mrs Richard Worth
Mr Kenneth H. Yocom
Mr James E. McClellan
Dr and Mrs Donald Pillsbury
Mrs J. P. Sims

LIBRARY ACCESSIONS

The following volumes have been added to the Arboretum Library during the last six months:

**Adventures in my Garden and Rock Garden*, L. B. Wilder (Doubleday, Page & Co., 1923)

***British Flora*, v. 1, W. J. Hooker (London, 1838)

Cactaceas de Mexico, H. Bravo (Mexico, 1937)

***Catalogue of North American Plants north of Mexico*, A. A. Heller (Lancaster, 1900)

Compendio de la Flora Española, 3 parts. B. Lazaro & Ibiza (Madrid, 1920)

Encyclopedia of Annual and Perennial Garden Plants, C. O. Booth (London, 1957)

***Enumeratio Plantarum*, 5 vols. C. S. Kunth (Stuttgart & Tubingen, 1833)

***Flora Barbiensis*, F. A. Scholler (Leipsic, 1775)

Flora of British India, 7 vols. J. D. Hooker (London, 1872)

Flora of the District of Columbia and Vicinity, A. S. Hitchcock, et al. (Washington, 1919)

Flora of the Lancetilla Valley, Honduras, P. C. Standley (Chicago, 1931)

Flora Mexicana, M. Sesse & J. M. Mocino (Mexico, 1894)

***Flora of New Mexico*, E. O. Wooton & P. C. Standley (Washington, 1919)

Flora of the Panama Canal Zone, P. C. Standley (Washington, 1928)

Flore du Sénégal, J. Berhaut (Dakar, 1954)

Flora of Surinam, A. Pulle (Amsterdam, 1953)

Flora of Tropical East Africa, W. B. Turrill & E. Milne-Redhead (London, 1952-54)

***Flora of Yucatan*, P. C. Standley (Chicago, 1930)

Flore de la France, 3 vols., H. Coste (Paris, 1937)

Flower and the Bee, John H. Lovell (Scribners, 1918)

***Handbook of the Flora of Philadelphia and Vicinity*, I. A. Keller & S. Brown (Philadelphia, 1905)

***Indigenous Trees of the Hawaiian Islands*, J. F. Rock (Honolulu, 1913)

***Insectivorous Plants*, C. R. Darwin (Appleton, 1875)

Lilies of Eastern Asia, E. H. Wilson (London, 1929)

***Manual of the Botany of the Northern U. S.*, Ed. 6, A. Gray (New York, 1890)

Materia Medica Vegetabilis, 3 vols. E. F. Steinmetz (Amsterdam, 1954)

Notes on Useful Plants of Mexico, J. N. Rose (Washington, 1899)

Plant Propagation Practices, J. S. Wells (Macmillan, 1955)

Royal Botanic Garden, Calcutta, Anniversary Volume (Calcutta, 1938)

***Student's Flora of Egypt*, V. Tackholm (Cairo, 1956)

Sylva or a Discourse of Forest Trees, J. Evelyn (London, 1679)

Trees and Shrubs of Mexico, 5 parts, P. C. Standley (Washington, 1920-26)

Vascular Plants of the Pacific Northwest, part 5, Compositae, C. L. Hitchcock, A. Cronquist, et al. (Seattle, 1955)

***Vascular Plants of S. Tomé*, A. W. Excell (London, 1944)

Wayside Trees of Malaya, 2 vols., E. J. H. Corner (Singapore, 1951)

*Gift of Dr. E. T. Wherry

**Gift of Philadelphia Academy of Natural Sciences

Publications by Members of the Staff

The following books by members of the Staff of the Morris Arboretum are available at reduced prices to Associates:

Wherry, E. T. *The Genus Phlox*. Morris Arboretum Monographs III. 174 pages. Illust. Philadelphia 1955. $4.00. Price to Associates, $3.00

Wherry, E. T. *Wild Flower Guide*. 202 pages. 106 plates. New York 1948. $3.50. Price to Associates, $3.00

Wherry, E. T. *Guide to Eastern Ferns*. 220 pages. Illust. Lancaster 1937. $2.00. Price to Associates, $1.50

Li, H. L. *Chinese Flower Arrangement*. 122 pages. 10 figs. 20 plates. Philadelphia 1956. $4.00. Price to Associates, $3.50

Fogg, J. M., Jr. *Weeds of Lawn and Garden*. 215 pages. 176 figs. Philadelphia 1945. $3.00. Price to Associates, $2.50

Please send orders and remittances to:

The Associates of the Morris Arboretum
The Morris Arboretum
9414 Meadowbrook Avenue
Philadelphia 18, Pa.

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